EXECUTIVE SUMMARY

Peter J. Sousounis
University of Michigan, Ann Arbor, Michigan

1. INTRODUCTION

The Upper Great Lakes Workshop, sponsored by the U.S. Environmental Protection Agency (USEPA), was held at the University of Michigan in Ann Arbor, Michigan from 4-7 May 1998 to discuss some of the potential consequences of climate change in the Upper Great Lakes region (e.g., Minnesota, Wisconsin, and Michigan). The workshop was one of 19 workshops that were sponsored by the U.S. Global Change Research Program through other federal agencies. For example, the U.S. Environmental Protection Agency sponsored the Upper Great Lakes Workshop, while the National Aeronatics and Space Administration (NASA) sponsored similar workshops in the Southeastern United States. The workshop addressed four questions: (1) What are the current stresses in the region? (2) How will climate change and climate variability ameliorate or exacerbate these stresses? (3) What additional information is needed to understand better the impacts of climate change and variability in the region? and (4) What are the coping mechanisms that would minimize the (negative) impacts of climate change in the region? The workshop was unique for this region because it brought together over 120 stakeholders from industry, government, academia, and environmental groups who had concerns about climate change.

2. PLENARY SESSIONS

The workshop began with an informal slide presentation given by Professor John Fraser Hart from the University of Minnesota on Monday evening (4 May). The slide show highlighted some concerns about how climate change may impact life in the Great Lakes region, and gave attendees some food for thought as they prepared for intense discussion over the next two and a half days.

On Tuesday morning, Robert Corell (National Science Foundation) talked about the importance of the workshop from a National Assessment standpoint. Michael MacCracken (U.S. Global Change Research Program) talked about the current state of knowledge as far as global climate change is concerned. Derek Winstanley (Illinois State Water Survey) talked about some of the regional patterns of climate that have been exhibited in the Upper Great Lakes region and really put the concept of climate change and variability in perspective. Professor Otto Doering (Purdue University) concluded the morning session by discussing some of the impacts that climate change may have on the Upper Great Lakes region as far as agriculture, industry, and the economy are concerned.

Professor John Magnuson (University of Wisconsin) gave an informal talk during lunch regarding some of the anticipated ecological impacts from climate change. The afternoon was reserved for Breakout Sessions I and II. That evening, Michael Noble (Minnesotans for an Energy Efficient Economy) talked about energy conservation and climate change.

Wednesday morning began with a summary from each of the breakout groups regarding their discussions from the previous day. Linda Mortsch (Environment Canada) followed with a discussion of additional information that is needed to help everyone understand the potential impacts of climate change. The talk was motivation for Breakout Session III. At lunch, Charles B. Kitz from the Chrysler Corporation presented thoughts about climate change from a business perspective. After lunch, a talk by

Joel Scheraga (U.S. Environmental Protection Agency) that focused on mechanisms that are or that may be available to cope with climate change provided motivation for Breakout Session IV.

Each of the breakout groups provided summaries of their four breakout sessions on Thursday morning. Note that the invited talks given by the speakers are provided in Appendix 1.

3. STAKEHOLDER CONCERNS

Stakeholders divided into breakout groups to discuss the above mentioned questions as they related to important regional sectors: water resources (WRES), water ecology (WECO), land ecology (LECO), agriculture (AGRI), infrastructure (INFR), economy (ECON), and human health (HLTH). Additionally, breakout sessions that focused on Climate, and Governance & Education were conducted.

3.1 Climate

The Climate breakout group focused on a series of questions that differed from those discussed in most other sectors. One major theme of the breakout discussions was the assessment of the natural variability of the regional climate. Understanding the short-term and long-term natural variability is important both for understanding the behavior of the regional climate and for assessing the performance of General Circulation Models (GCMs) simulations for the region. The breakout group emphasized the importance of a quality observational record for evaluating climate variability and discussed the many limitations of the available historical climatological record. Alternative means for enhancing and extending the climatological record, such as the use of proxy data, were also discussed.

A second major theme was the role of General Circulation Models (GCMs) in impacts analysis. The breakout group acknowledged that the limitations of the current family of models make assessing regional climate change difficult. Regional climate models and statistical downscaling were advocated as ways to provide greater spatial detail and richness to climate scenarios. The breakout group emphasized that the unique meteorology of the Great Lakes region needs to be carefully considered in model simulations and in any impacts analyses.

General recommendations of the breakout group were that more research is needed to better understand past and current climate variability in the Upper Great Lakes region. More research is also needed to evaluate the behavior of GCMs at different levels of greenhouse gas forcing. Finally, a better understanding of the interaction between the large water bodies of the Great Lakes and the regional climate is necessary before long term climate impacts can be adequately assessed.

3.2 Water Resources

Understanding the impacts on water resources is the linchpin to understanding impacts of climate change on other sectors. The water in the Great Lakes - St. Lawrence Basin serves as a resource for sustaining human life, ecology, agriculture, trade, energy generation, and recreation, to name a few.

Stakeholders composed a list of stresses and discussed how they would be affected by climate change. Despite the uncertainties in future climate predictions because models (e.g., general circulation models) either exclude or do not incorporate properly the Great Lakes, it was generally agreed that climate change would exacerbate these stresses.

Stakeholders raised concerns about decreased lake levels or net basin supply (NBS), which may result from lower land-based runoff (from higher evapotranspiration) and higher lake evaporation during the fall and early winter. The predicted reductions in lake levels ranged from 0.5 m on Lake Superior, from the Goddard Institute for Space Studies (GISS) and Oregon State University (OSU) models, to 2.5 m on Lakes Michigan and Lake Huron, from the Geophysical Fluid Dynamics model. These decreased lake levels would result in a 20-40% outflow reduction of the St. Lawrence River.

Stakeholders expressed unanimously the need for improved regional climate models. They noted that the ultimate goal is to develop and run these high resolution climate models to simulate accurately the impacts of global and regional climate change on individual watersheds.

3.3 Water Ecology

The Great Lakes Basin supports 131 elements (i.e., plant and animal species as well as community types) that are critically imperiled or rare on a global scale.

Stakeholders noted that current stresses from agricultural practices (e.g., fertilizers, pesticides, animal waste), urbanization, forestry and recreation uses, shoreline modification, dam and hydrological manipulation, eutrophication, toxics and contaminants, and accidental introduction of exotic species, were of greatest concern.

Stakeholders noted that any changes in climate such as mean temperature, seasonality, weather extremes, ice, water levels, runoff, wind and cloud cover could have strong and hard-to-predict impacts on aquatic systems. One example that was discussed was the potential effects on deep inland lakes. Temperature increases could decrease the hypolimnion, leading to a decrease in dissolved oxygen, a decrease in lake primary productivity, and a decrease in coldwater fish populations. These increases could also decrease ice cover and reduce winter kills. Overall changes in the seasonal patterns of freezing/thawing, and water level, for example, could interfere with aspects of fish (and other species) life histories, such as timing of reproduction. Still, the stress that may prove to be most important regarding aquatic ecosystem health is how land-use changes as a result of changing climate.

It was noted that declines in water levels may cause coastal wetlands to migrate lakeward and inland wetlands to 'dry out'. Impaired water quality could lessen fish health, survival, and productivity. Warm water fish species could replace cool water species. The biodiversity loss could have indirect impacts. For example, loss of genetic material may prevent new innovations in the agricultural and pharmaceutical industries.

Stakeholders indicated that better models are needed, that integrate climate, landscape, hydrology, and terrestrial and aquatic ecosystems. Some important coping mechanisms included promoting the consideration of environmental costs (externalities) in cost/benefit assessments of various planning and mitigation strategies, increased efforts at public outreach and education regarding the potential effects of climate change on aquatic ecosystems, and the development of adequate restoration techniques for aquatic systems.

3.4 Land Ecology

A unique combination of soils and climate allows abundant coniferous tree growth throughout the Upper Great Lakes region. Michigan ranks second only behind Oregon in Christmas Tree production.

Stakeholders discussed how regional climate change may displace forest zones with decreased acreage of boreal forests. Higher temperatures could lead to increases in forest growth rates in marginal areas that are now limited by temperature. Increased potential for damage from fires, pests, and diseases is possible. The southern transition zone of the boreal forest is susceptible to expansion of temperate forests. Temperate forests may have to compete with other land-use pressures. Stakeholders generally agreed that the rate of temperature change will likely exceed the rate of species migration. Massive diebacks could occur. Changes in both forest resource availability (supply) and demand are expected.

Stakeholders listed some important stresses including land-use changes from population growth and redistribution, urban expansion, agriculture, mining, forestry, and recreation. Additional stresses occur from disease, fragmentation, pests (Gypsy Moth), exotic species, and natural disasters such as fire and flood. It was noted that climate change would likely exacerbate most of these stresses.

Stakeholders wanted better systems to monitor land-use changes and climate changes; better models of land-use dynamics to produce scenarios; and more information on historical species migration and carbon sequestration of forests.

Public education was noted as an important coping strategy. Other strategies included facilitating species migrations where possible; planning and policy to anticipate land-use conflicts; rethinking fire and pest management strategies in light of changing climate; and understanding what current strategies are failing.

3.5 Agriculture

The Upper Great Lakes region has a combined climate and soil regime that makes most of it suitable for farming. Less than four percent of all the farms are irrigated at present. The region as a whole is suitable for growing eight of the top ten food crops in the world. Michigan, for example, is a leading producer of several varieties of beans, tart cherries, cultivated blueberries, cucumbers, and greenhouse flowers. Minnesota is a leading producer of sugar beets, dark red kidney beans, processed sweet corn, and green peas, and ranks third nationally in hog production. Wisconsin is a leading producer of many dairy products in the Upper Great Lakes region.

Stakeholders discussed a variety of economic, environmental, societal, and climatological stresses and noted difficulties in determining whether the direct effects from regional climate change would have a positive or negative impact. For example, a longer growing season would not necessarily translate to more agricultural productivity in the region because precipitation distributions may change unfavorably and also because soils in the northern part of the region are not necessarily suitable to support the same types of crops that are now limited to southern portions of the region. Stakeholders also expressed difficulty in determining whether the indirect stresses, which are related to economics, government regulations, and population demographics, would be impacted by climate change and if so how.

Stakeholders believed that the most useful additional information they could obtain was to understand more accurately how regional climate, especially weather extremes and interannual variability, would change.

Some coping strategies included increased use of irrigation to compensate for possibly drier conditions, government policies to get farmers through difficult years, and increased use of reduced tillage systems to provide the potential for significant carbon sequestration and to realize the benefits of improved tillage, soil fertility, and water holding capacity.

3.6 Infrastructure

The Great Lakes/St. Lawrence Seaway constitutes a major international waterway, which serves a region that has approximately 50 ports, 25% of North America's population, creates more than 1/3 of the continent's gross national product, produces 2/3 of Canada's industrial output, grows about 1/2 the soybean and corn in the U.S., and accounts for some 40% of U.S. manufacturing. Several power plants generate electricity for the lower Great Lakes region.

Stakeholders raised concerns about possible increases in extreme weather events (as a result of climate change) that would further stress energy demands, power lines, and buildings. There was also concern that overall increases in temperature would shift the energy demand period from winter to summer.

Concerns were also raised about reduced water levels. Without dredging, ships would likely have to reduce their cargoes to navigate shallower channels. But, a longer (ice-free) shipping season may allow for shipping more, smaller loads, resulting in no net annual loss. Dredging, lowering docks, extending water supply sources and storm water outfalls are costly actions that may have to be implemented. Hydropower production along the Niagara and St. Lawrence Rivers could be reduced by lower lake levels and higher water temperatures. A reduction in hydropower may be further strained by increased demand for energy for air conditioning and refrigeration during the summer months.

Stakeholders wanted more information on extreme weather events; an integrated Geographical Information System (GIS) database for infrastructure characteristics; information about infrastructure use by various population segments; and cost/benefit analyses of different policy options. Stakeholders also wanted better regional climate models.

3.7 Economy

The Great Lakes region is the Industrial Heartland of the U.S. It is a leader in automobile, paper product, medical, chemical, and pharmaceutical production. Recreation is also important economically to the region. Michigan has more registered boaters and more golf courses than any other state. Ice fishing and snowmobiling are popular pastimes in the region.

Stakeholders noted that stresses associated with climate change in the Great Lakes region are centered around three key issues: historical tensions between economy and environment, economic realities which exist for businesses, and the impacts of social factors.

It was noted that most aspects of industry and manufacturing in the Upper Great Lakes region are not vulnerable to the direct effects of the predicted changes in temperature, precipitation, or weather variability associated with climate change. Exceptions include tourism, recreation, and agriculture, where negative and positive impacts may offset each other. Nevertheless, the economy and commerce of the region are highly vulnerable to the indirect effects of climate change. That is, public opinion has the potential to vastly change markets; altered governmental policy has the potential, if not carefully designed, to devastate Great Lakes industries.

Extensive economic modeling with numerous possible policy responses is needed so industry may best adapt to potential changes. Multiple government-scientist-industry partnerships are needed to facilitate communication and information exchange. The media should have reliable information sources that are not slanted toward scare tactics.

Education of the general public and business people in both direct and indirect impacts of climate change were mentioned as a powerful coping mechanism. Part of that education should include an understanding of the constraints under which industry/commerce operate.

The key tools that can facilitate adaptation of industry/commerce to climate change are policies that set an economic environment (e.g., remove barriers that impede change), and the promotion of consumer markets. It was noted that responses to climate change should be tested for dual benefit. That is, the best response would not only address climate change, but also ways to stimulate desirable economic growth and economic opportunity, energy (and other) efficiency, and innovation.

Numerous coping strategies such as lifestyle changes, better building standards, and more resilient energy sources, were discussed.

3.8 Human Health

Stakeholders listed stresses for health care, environment, and lifestyle. A major health care stress was its limited access. Severe weather events (weather extremes), and air/water quality were also noted. Finally, lifestyle choices including diet, tobacco, alcohol, and drug use were listed as stresses on human health. Stakeholders noted that some anticipated aspects of climate change could further impact human health. For example, increased frequency/change in timing or locations of severe weather events (extended heat/cold waves, tornadoes, lightning, heavy rains, floods) could lead to increased injury and mortality. Extended heat/cold waves with low winds would be conducive to increased levels of air pollutants (i.e. tropospheric ozone, particulates) and could lead to increased morbidity and mortality. Some effects could be indirect such as those from increased survival of vector-borne pathogens because of milder winters; increased Lyme disease from more frequent precipitation; and increased toxins in food and water from increased use of pesticides to control infestations.

Informational needs included better regional climate models to evaluate the regional-scale implications of climate change/variability (i.e. for the Upper Great Lakes region), and better monitoring of high risk areas, sensitive populations, and important socioeconomic factors so that public health methods can be developed and implemented to prevent/reduce health impacts.

Coping mechanisms included the development of integrated weather forecasting and health warnings (i.e. broaden current ozone, pollen warnings); educating the general public, health care professionals, and government officials about the potential impacts of climate change on human health; and keeping people out of high risk areas (i.e. flood plains).

3.9 Governance & Education

The Governance & Education breakout group discussed governance and educational issues on two different days. Separate sets of questions were developed for both portions because the questions asked in the other breakout groups did not directly apply to governance and education.

Regarding governance, some stakeholders felt that governments should stay clear because they are too slow and inefficient to facilitate the radical and innovative measures that may be needed to deal with climate change. Other stakeholders felt that governments should provide strong international, domestic, and local leadership. These stakeholders also felt that governments should continue to fund research programs in environmental science and renewable energy resource development and communicate the results of this research to the public in a politically unbiased manner. Stakeholders also felt that governments should participate in voluntary partnerships with business and industry so that the two groups can work together, instead of against each other, to modify industrial practices that have a negative impact on the environment.

Regarding education, stakeholders emphasized the importance of disseminating information about climate change during times when the public's attention is focused on Earth's climate (e.g., weather catastrophe). Stakeholders also noted that the information should include a general description of the atmosphere and the greenhouse effect and that all things are known about climate change, but the consequences of many climate change scenarios must be considered. Importantly, stakeholders noted that the public should understand that scientific data can be interpreted in different ways in order to promote a specific point of view. Finally, stakeholders noted that people should realize that the causes of climate change are directly linked to human behavior.

4. CLOSING REMARKS

The Upper Great Lakes region has much at stake when it comes to considering the potential impacts of climate change. Its importance from hydrological, agricultural, industrial, and recreational perspectives, to name a few, means that even slight climate changes and slight changes in weather extreme patterns could have significant impacts.

The Upper Great Lakes Workshop served as a mechanism to identify concerns of people who have a stake in the future of the Great Lakes region. These concerns are being addressed in a follow-up assessment. The assessment will consider how regional climate change, as defined by newly available scenarios that include the Great Lakes and other what-if scenarios, will impact some of the sectors that were discussed at the workshop.